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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

Re: RM-8610 - Report of Ex Parte Presentation

Dear Mr. Caton:

On March 15, 1995, Ralph H. Justus, Director of Engineering of the Consumer Electronics Group of the Electronic Industries Association ("EIA/CEG") met with Thomas Tycz, Harold Ng, and Rosalee Chiara of the Satellite and Radiocommunication Division of the International Bureau to update them on EIA/CEG's activities in testing digital audio radio systems and the anticipated timeframe for reporting test data results. The materials used at the meeting are attached for entry into the record.

This letter and the extra copy of this letter are being transmitted in accordance with Section 1.1206(a) of the Commission's rules. Please let me know if you have any questions.

Sincerely,

Jeffrey A. Campbell

Enclosure

cc: Thomas Tycz
Harold Ng
Rosalee Chiara

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List A B C D E

EIA Digital Audio Radio Subcommittee
Activities Summary
3/15/95

1. The Electronic Industries Association's Consumer Electronics Group (EIA/CEG) formed its DAR Subcommittee in October, 1991 to centralize industry activities for testing and evaluation of proposed DAR technologies. Nine potential systems had surfaced at that time. The following systems eventually submitted hardware for testing, two of which have a "second mode" of operation:

AT&T	in-band (FM)/adjacent channel
AT&T/Amati Communications Corp.	in-band(FM)/on-channel (IBOC)*
Thomson CE for Eureka 147/DAB	new-band (L-band testing)*
USA Digital Radio	IBOC FM implementation #1
USA Digital Radio	IBOC FM implementation #2
USA Digital Radio	IBOC AM
Voice of America/Jet Propulsion Lab	direct broadcast satellite (S-band)

* - proposes "second mode"

Laboratory testing at NASA's Lewis Research Center in Cleveland, Ohio, began April, 1994 and completion is expected June/July, 1995. Field testing is currently under planning and the targeted venue is San Francisco, CA due to its varied terrain and multipath environments and the willingness of local broadcasters to loan transmitting sites at their facilities. Current plans are to conduct field measurements for two months in the July/August, 1995 period. Total costs are expected to exceed $1,200,000 and have been borne principally by EIA/CEG and proponents, with contributions by other organizations, including the National Association of Broadcasters, Delco Electronics, Corporation for Public Broadcasting, and others.

2. The National Radio Systems Committee (sponsored jointly by EIA/CEG and the National Association of Broadcasters) formed its DAB Subcommittee at broadcaster insistence to (1) have broadcasters hold a stronger influence in developing an IBOC DAR approach (consistent with NAB's policy objective) and (2) minimize the possibility to compare IBOC systems with non-IBOC systems.

3. Commission staff (OET & MMB) participate in the Subcommittees' activities and have visited the test site at NASA LeRC. Now pending before the Commission are two experimental broadcast applications related to terrestrial field testing: (1) use of an FM broadcast frequency to test the AT&T in-band/adjacent-channel (IBAC) system; (2) use of L-band (1452-1492 MHz) frequencies to test the Eureka 147/DAB system. [NTIA objections to L-band use have been coordinated and their grudging approval is expected.] Authorization to employ IBOC facilities on stations KBGG(FM) and KABL-AM) will be requested shortly by Special Temporary Authorization request letter.

4. EIA/CEG's position has been to not foreclose <u>any</u> options for DAR implementation until the results of testing can be evaluated.

COMPARATIVE EVALUATION OF DIGITAL AUDIO RADIO SYSTEMS IN THE UNITED STATES : AN OVERVIEW OF THE EIA DAR SUBCOMMITTEE AND STATUS OF ITS WORK

Randall Brunts *
Delco Electronics and Chairman of the EIA DAR Subcommittee

ABSTRACT

The Electronic Industries Association's (EIA's) Consumer Electronics Group established its Digital Audio Radio Subcommittee to provide an objective, impartial venue to compare technologies proposed for DAR and to select a single system for standardization. The Subcommittee was patterned after the Broadcast Television Systems Committee (BTSC) of EIA that successfully developed the multichannel TV sound system in use throughout North America. Some industry segments were concerned by different DAR implementation scenarios and this resulted in restructuring the Subcommittee's procedures to include analysis and evaluation of in-band/on-channel DAR systems by the National Radio Systems Committee (NRSC) which is a joint committee of the EIA and National Association of Broadcasters (NAB). Testing of systems is under way and these results will be analyzed with the objective of recommending a system (or systems) to the Federal Communications Commission for adoption.

This paper will describe the need for comparative evaluations, the organization and evolution of the Subcommittee, its initiation of the testing program, plans for arriving at a consensus, and observations on the "modus operandi" of the committee for standards setting.

INTRODUCTION

In October of 1991 the EIA issued an open invitation for interested organizations and groups to form a subcommittee of the EIA's Audio Committee (R-3) which would be chartered do an open evaluation of the proposals for digital audio radio services then known to be under development. It was clear to many in the radio industry that reaching a DAR standard consensus given the competing proposals with differing claims of technical and economic superiority would require an open standards process. The resulting subcommittee has benefited from the participation of scores of organizations, groups, and individuals, the contribution of countless hours of support, as well as financial and material resource contributions. This paper describes the process we have gone through, the progress we have made, and the path we plan to take from here. It will also make some observations on the process itself in hopes that these will be a benefit to future such efforts.

ROLE OF THE EIA DAR SUBCOMMITTEE

The EIA's DAR Subcommittee is chartered to set service objectives for a new U.S. digital audio radio system, develop test procedures to analyze systems, test and evaluate all DAR

systems presented by qualified proponents, report the test results, and recommend steps for standardization of DAR in the United States. This charter was generally specified by the EIA's R-3 Audio Committee but was made more specific by the founding members of the Subcommittee in the course of the first few meetings.

The overall objective of the process has been to help insure that the United States adopts a new radio service that will meet the needs of the public to the greatest extent technically possible and that this new service will be available in the near term. Measuring of how well a system meets the public's needs requires that we evaluate quality of service, range of services, cost of providing/receiving the services, and the time required to make all required infrastructure available. With these facts and goals in mind the committee adopted a set of service objectives and evaluation criterion to inform potential proponents and guide our decision processes.

The six service objectives officially adopted by the Subcommittee are:

1. CD Quality Sound
2. Immunity to Multipath and Other Interference
3. No Objectionable Interference to Other Services
4. Minimization of Transmission Costs and Reception Complexity and Costs
5. Additional Data Capacity
6. Degradation at the Reception Area Threshold with a Minimum of Objectionable Artifacts.

RELATIONSHIP WITH THE NRSC DAB SUBCOMMITTEE

In the Spring of 1993 the National Radio Systems Committee (NRSC) voted to form a Subcommittee on Digital Audio Broadcasting (DAB) chartered to evaluate DAB systems that operate within the existing broadcast station allocations. These systems (often called In-Band On-Channel) are believed by U.S. broadcasters to avoid the need for new licenses from the FCC because they represent only a service enhancement of the current system.

In fact the NRSC, which is a joint committee of the NAB and EIA, took its action to allow NAB to more formally participate in the standards process. The NAB felt that direct participation in the EIA process would imply support for direct comparison of all DAR systems which was contrary to the interests of NAB members.

The new arrangement provided that the EIA DAR Subcommittee would conduct all tests of DAR systems under equivalent conditions. Subsequently, the NRSC Subcommittee would evaluate all In-Band On-Channel system results, and the EIA Subcommittee would evaluate all other systems. All data would be made available through the committee processes and released to all participants. This is the agreement governing cooperation between the two organizations and the authority by which the EIA has initiated testing of proponent systems.

NEED FOR COMPARATIVE EVALUATIONS

The selection of a new DAB system is a decision of serious importance. It will determine the types and quality of services the U.S. public will receive from broadcasters for decades to come. If a poor decision is made I have no doubt the public will still receive the services they desire, but these services may be delivered at higher cost, less convenience, and from different sources than would otherwise be the case. Poor decisions could also be expensive in terms of inefficient use of radio spectrum, degradation of existing services, or a slow rate of introduction.

In the absence of quantitative data on the performance of alternative DAR systems, the complex tradeoffs required for a good decision simply cannot be intelligently made. One can see from the service objectives that DAR systems must be measured against a range of desired results. Most of these cannot be determined in absolute terms and some of them are purely subjective. Beyond that, it is very likely that different groups would give very different ratings to the relative importance of these objectives. The comparative data collected by the testing process is an essential foundation for the consensus decision process that will follow.

The testing process cannot produce a numerical result that indicates the best system for use in the United States, but it must give quantitative answers to the degree and practical significance of compromises each system will require in each of the service objectives. The development of satisfactory test plans is critical to the success of the process and, as a result, has been the most important part of the EIA/NRSC process. Tom Keller, the chairman of the testing working group will be submitting a paper to this symposium describing the open process by which test plans were developed. The test plan development process has spanned nearly two years of intensive effort.

Although the quality of a DAR system is in many respects a subjective judgment, these judgments can be reduced to reliable quantitative comparisons. The subjective testing planned for the testing process will be carried out under double-blind conditions by the Communications Research Centre (CRC) in Canada. This is a critical, and expensive, phase in the process and we are very fortunate to have the cooperation of such a well qualified facility. The result, we expect, will be qualitative data that compare the subjective aspects of system characteristics critical to the selection of the best available radio system.

PROGRESS REPORT

The process of developing a national consensus on something as important as DAR can fill the uninitiated with hopelessness, frustration, and despair. I suspect it has about the same affect on veterans, it's just that they aren't as surprised. As chairman, I have often been amazed by how long the process takes and how much effort. But I have seldom felt that we could do a better job by introducing new constraints or changing the rules of the game. If the open process has taken longer it is because openness has forced us to do better. If we only had to answer the questions that occurred to any one of us, the task would be a simple one. But throughout the process, participants have introduced problems and questions no one else had thought of, but upon further examination, turned out to be important.

The result is that the DAR Subcommittee has made much concrete progress toward fulfilling its charter. We have decided what DAR should be and how it should be measured. We have developed a thorough test plan to collect system performance data. We have collected sophisticated characterization data describing the environment FM systems must accommodate, data which did not previously exist. We have designed and built a laboratory to carry out planned tests in facilities graciously contributed by NASA's Lewis Research Center. And we have begun the actual testing process. By March of 1994 testing will be well under way and I will be able to report on preparation to evaluate the data and make recommendations.

Five system proponents have submitted their hardware to the test laboratory for testing. They are Amati/AT&T, AT&T, the EUREKA-147 Program Board, NASA/Voice of America, and USA Digital Radio. Each of these proponents has invested in the development of a DAR system and contributed materially to defray testing costs.

This progress has not been simple or inexpensive to make. Proponents, trade groups, manufacturers, and agencies alike have contributed much time and resource to the task. The work ahead will be no easier, but at this point I have no doubt it will be done.

PLANS FOR ARRIVING AT A CONSENSUS

As mentioned previously, the proponent systems will be evaluated in two groups. The NRSC DAB Subcommittee will consider all IBOC systems, while the EIA DAR Subcommittee will consider all other proponent systems. Comparative evaluation of the recommendations of each group will only be taken up after these processes are complete and will probably not be done by the same subcommittees.

The EIA recommendation will be based on all service objectives. At this time there is no intention of weighting the factors for importance. The subcommittee has not adopted formal consensus procedures at the time of this writing, but one suggestion may be as follows:

1) Consider and rank all proponent systems according to performance in each service objective, considering one objective at a time. The performance of each proponent would then be labeled acceptable or unacceptable in this area.

2) Rank all proponents on overall performance.

3) Examine the differences between the highest ranked system and its nearest competition to determine what recommendation should be made and how strongly the recommendation should be put.

4) Draft the subcommittee recommendation and forward to the EIA R-3 (Audio) Committee for approval and action.

By the time this paper is delivered a more definite form of consensus process may be in place. Such developments will be reported at that time.

OBSERVATIONS ON THE PROCESS

There are three important observations worth making from the process to date. These have to do with technology vs. politics, cost vs. accuracy, and open mindedness vs. fear.

First, over the past two years I have been asked if the EIA process is a technical process or a political process. The implication has been that a technical process is clean, wholesome, and honorable. Conversely, that politics is dirty. My own opinion of the situation has evolved over that period but today I am comfortable with the nature of the process.

As an engineer and foreigner to Washington, D.C. I had tendencies toward the "politics is dirty" bias when this process began. But now I believe that politics is the process by which groups with different interests resolve their differences so they can move forward. Politics would be unnecessary only if all groups' interests were the same. Technology offers us a tool to measure the benefits and costs that might accrue to different stakeholders, but the final decision cannot be made by technology. Large decisions, like it or not, are the realm of politics.

Second, I would like to observe that there is no comprehensive test, no exhaustive comparison, and no fool proof evaluation. The quality of testing is a matter of what you feel you need and what you can afford. Very good testing can be done today for much less than such activities would have cost in the past. But this can lead to the perception that testing can be "complete". We must realize and accept than no test plan is "complete", but take some comfort in the fact that we can do and have done much better than previous radio testing processes had any hope of doing.

Finally, the enemy of good decision-making in standards efforts is not politics, but fear. If the political process is used as a means of negotiating the competing interests of groups and searching for common ground the process will work well. But if an important group can be convinced to suppress the discovery and debate of issues because of a fear of disaster, the process fails. The most critical step, therefore, is to work to make all parties comfortable enough to participate in the discovery of information needed to assess the alternatives. Information greatly reduces the fear and makes room for political solutions.

CONCLUSION

Taken together, the EIA and NRSC processes are giant steps toward the development of a national consensus on DAB in the United States. The processes are moving well and are headed toward a successful conclusion. The technical information these processes produce is a critical element of the political process required to finally produce a national consensus on DAB.

Such processes are time consuming, expensive and are best reserved for matters of significant complexity where the consequences are great. The potential of DAB is fully deserving of this effort and expense. As chairman of the EIA's DAR Subcommittee and Co-chairman of the NRSC's DAB Subcommittee I would like to thank all those individuals and organizations who have contributed so much toward reaching our goal.

#6

LABORATORY TESTING DIGITAL AUDIO RADIO IN THE U.S.

Thomas B. Keller
Chairman DAR Testing Working Group B
Consultant/EIA

ABSTRACT

The Electronic Industries Association Subcommittee on Digital Audio Radio and the National Radio Systems Committee DAR Subcommittee are in the process of evaluating proposed digital radio systems for standardization. Test Working Group B of the EIA DAR Subcommittee is responsible for conducting the laboratory and field tests for the seven proposed DAR systems. Of these, four of the DAR systems are intended to operate in the VHF 88 MHz to 108 MHz FM band, one in the medium wave band (AM), one in the satellite band, and one in a new terrestrial band. Of the four systems intended to operate in the FM band, one of the systems is designed to operate on adjacent channels and the remaining three are intended to share existing channels. The in-band/on-channel (IBOC) DAR system tests is being conducted in partnership with the National Radio Systems Committee.

This paper will describe the DAR test, the materials used for testing, and the test schedule.

INTRODUCTION

The DAR tests are being conducted in two laboratories, the transmission laboratory at NASA Lewis Research Center, Cleveland, Ohio, and the expert subjective test at the Communications Research Centre Subjective Quality Assessment Laboratory, Ottawa, Ontario. The tests at Lewis, Cleveland will be in two phases, digital and in-band compatibility. The digital phase will evaluate quality and signal failure. Additionally, the digital test will include multipath, co-channel, and adjacent channel impairments. The in-band compatibility phase of the transmission tests being conducted at the transmission test laboratory will include a test to measure possible interference to the existing analog program services caused by the introduction of in-band DAR. Comprehensive tests will also be conducted to measure possible interference to subcarrier ancillary services channels by the in-band DAR signal. For the in-band compatibility tests, the committee will select a group of receivers that is representative of the existing analog receiver population.

Threshold of audibility and point of failure tests for the digital systems will be conducted by the laboratory specialists in Cleveland. The results of transmission tests that are to be assessed by experts will be digitally recorded at the transmission laboratory and sent to CRC.

In-band compatibility objective tests will be conducted at the transmission laboratory. Digital audio tape recordings will be made at the output of the analog compatibility receivers for subjective evaluation by industry experts.

This paper describes a portion of the continuing DAR process. Changes that may be effected between the submission of the manuscript and the distribution of this document will be noted in the presentation at the conference.

Working Group B

The EIA DAR Subcommittee Working Group B on testing started meeting in the summer of 1992. The working group has completed a laboratory test plan, established a transmission test laboratory, selected a subjective testing laboratory, characterized the transmission multipath for the FM band (88MHz to 108MHz), and started the laboratory testing process. At the time this paper is presented, the WG-B will be in the process of preparing field test procedures.

The seven DAR systems that have been presented to the working group by the DAR Subcommittee have been divided into five subgroups. Table 1 shows the proponent, frequency of operation, and the designated subgroup. Three of the proponent systems include a second mode of operation, Eureka 147, AT&T/Amati, and USIA/JPL.

Table 1 Systems

Proponent	Band	Subgroup	Subgroup Designator
Eureka 147*	1452-1492 MHz	New Band	NB
AT&T	88-108 MHz	In-Band/Adjacent Channel	IBAC
UDADR-AM	.54-1.7 MHz	In-Band/On-Channel	IBOC
AT&T/Amati*	88-108 MHz	In-Band/On-Channel	IBOC
USADR-FM #1	88-108 MHz	In-Band/On-Channel	IBOC
UDADR-FM #2	88-108 MHz	In-Band/On-Channel	IBOC
VOA/JPL*	2310-2360 MHz	Direct Broadcast Satellite	DBS

* Systems include a second mode.

TEST SCHEDULE

The tests will be conducted over a 33 week period. Each transmission test will be conducted on all seven systems during the same test period (parallel testing). The schedule is broken into five segments.

Weeks 1-2 Each proponent will be expected to take one day to install the DAR system in the transmission test laboratory and demonstrate the fundamental operation of the system. The demonstration will include the operation of transmitting and receiving apparatus.

Weeks 3-7 The interface for each DAR system should take three days. Each proponent will be assigned an individual date for interface, calibration, and a test rehearsal. After completing the interface, test A (Calibration) and elements of test B will be conducted for the test rehearsal.

Weeks 8-10 This period is reserved for the selection of audio test material for the quality and impairment tests from over 100 audio segments submitted to the Subcommittee.

Weeks 11-19 The digital transmission tests including quality tests, signal failure characterization tests, performance with impairments tests, DAR -> DAR with and without multipath tests, and reacquisition tests will be conducted.

Weeks 21-33 In-band compatibility DAR -> analog tests, analog -> DAR tests, and system specific tests will be conducted.

DAR TESTS DESCRIPTION

The test procedures prepared by Working Group B call for fifteen tests. Appendix A lists the fifteen tests.

CALIBRATION TEST A

This test is to certify that the test bed and the proponent systems are operating within specification. Daily, the system RF power, spectrum, and point of failure with noise will be measured and a digital recording will be made of each system's audio quality. Weekly, the in-band proponent analog transmitters, and the laboratories reference analog transmitter performance will be measured. The analog AM and FM modulation monitors will be checked weekly. The test bed will be re-calibrated monthly or whenever designated by the test director. System self checking programs supplied by the proponent will be run on a schedule mutually agreed by the proponents and the test director.

SIGNAL FAILURE CHARACTERIZATION TEST B

Test B is designed to characterize the digital signal failure with noise, co-channel interference, and noise with multipath. The tests will be conducted in the transmission laboratory (NASA Lewis), and the results will be assessed by expert listeners at the CRC in Ottawa. Impairment audio test material selected in test K-1 will be used for the digital audio. Three audio segments will be used for each impairment test. Processed audio will be used for the IBOC analog audio signal.

For the signal failure with noise test, gaussian noise will be added to the signal and the noise increased until point of failure is heard on the digital audio by the laboratory specialists. Point Of Failure (POF) is the point where the signal completely fails or the interference in very annoying. From the point of failure, the noise will be reduced until the laboratory specialists determine the threshold of audibility. The Threshold Of Audibility (TOA) is the point where the interference is perceptible, but not annoying. An attenuator with .25 dB steps will be used to find the TOA and POF. From the POF the noise will be reduced in 0.5 dB steps until the noise is 1.5 dB below the TOA. From this point the noise will be increased in .5 dB steps and digital recordings made at each step. This will be repeated for each of the three impairment audio segments. The digital audio tapes produced in these tests will be sent to the CRC in Ottawa for assessment by expert listeners. With the assessments made from these tapes, the failure characteristic can be plotted for each DAR system and for each impairment. Also, the TOA found at the transmission laboratory can be re-confirmed by the experts at the subjective assessment laboratory.

For the second part of test B, co-channel interference will be substituted for noise, and the tapes produced will be sent to the CRC for expert assessment.

Test B-3, mulltipath and noise, will be conducted four times, each with different multipath scenarios. The multipath parameters are being specified by the channel characterization sub-group of Working Group B. A paper describing how these scenarios were derived is being presented at this conference. The procedure followed here will be similar to the procedure used for the noise test. Digital recordings will be made for subjective assessment at the CRC.

Each of the DAR systems incorporates an ancillary data channel. The BER for this channel will be measured with the interference set at the level that produced TOA for each of the three impairments in test B.

PERFORMANCE WITH IMPAIRMENTS TEST C

This test will use the following impairments; impulse noise, CW, airplane flutter, weak signal, additional multipath scenarios not used in test B, and simulated environmental noise for the system that operates in the AM band. The test results will be reported with Expert Observation and Commentary (EO&C) by the laboratory specialists. The TOA and the POF will also be found in the transmission laboratory and reported.

DAR ->DAR TEST D & E

These tests will measure the DAR ->DAR interference to co-channel, first adjacent, and the second adjacent. Test E will be conducted with multipath added to the parameters in test D. This is an EO&C test by the transmission laboratory specialists. The D/U at the TOA and POU will be reported for each system.

DAR ->ANALOG COMPATIBILITY TESTS F & G

The compatibility tests are restricted to the IBOC and IBAC systems. The analog ->analog interference will be used as a reference and compared to the DAR ->analog interference. Co-channel, first adjacent, and second adjacent tests will be conducted for both tests F & G. The interference to the analog signal will be measured objectively and subjectively. Digital audio tapes will be recorded for further subjective assessment by industry experts. Test G is the same as test F with multipath added. Consumer receivers will be used for this compatibility test. For the FM band compatibility tests, five FM stereo, one monophonic, one receiver with subcarrier group A, and one with subcarrier group B will be used. Two stereo and 2 monophonic AM receivers will be used for the AM tests.

In-band DAR system compatibility with analog subcarrier test will be part of tests D & E. Table 2 shows the number, frequency and injection for the two subcarrier groups. Both objective and subjective EO&C measurements will made. For the RBDS and 66.5 kHz high speed digital, error measurements will be made.

TABLE 2

Subcarrier Test Group A		Subcarrier Test Group B	
RBDS	3%	RBDS	10%
66.5 kHz Digital	8.5%	67 kHz	10%
92 kHz	8.5%		

ANALOG->DAR COMPATIBILITY TESTS H & I

These tests will measure possible interference from the existing analog service to the digital service. The undesired analog signal will be heavily modulated to the legal maximum with processed stereo rock music. The desired DAB signal will be modulated with the impairment test audio. This is an EO&C test with the laboratory specialists determining the D/U at the TOA and POU for each of three audio impairment segments and for each DAR system. Test H & I will be conducted with the undesired analog signal on co-channel, first adjacent channel, simultaneous upper and lower first adjacent channels, second adjacent channel, and simultaneously on the upper and lower second adjacent channels.

The analog FM transmitter subcarrier to DAR compatibility test will be conducted listening to the desired digital audio. With the undesired FM signal level set to produce TOA, either the subcarrier group A or B will be switched on and the transmission laboratory specialist will note any change in the TOA. If a change in TOA is noted when either subcarrier group is on, the undesired FM signal will be reduced until a new TOA found. Test I is similar to test H with multipath added.

ACQUISITION AND REACQUISITION TEST J

This test will be conducted in two parts; weak signal failure acquisition time and reacquisition with simulated multipath and noise. The multipath test will measure the reacquisition times with four different multipath scenarios. This test will also measure hysteresis.

DAR QUALITY TEST K

This test, one of the most important in the series, will be conducted in two parts. The first part is the selection of audio test segments for the quality and impairment testing, and the second part is the actual quality testing.

Members of the working group have submitted digital audio materials on digital audio tape to be selected for test segments. Over a 100 proposed segments have been received for consideration. Pre-processed digital audio segments are also being considered. Each of the proposed audio segment will be transmitted through each complete DAR system, with and without impairments. The impairment RF noise and noise with multipath may be used to aid in the selection of critical test segments. Each segment will be monitored for impairments by the specialists in the transmission laboratory. Segments that are considered critical by the transmission laboratory specialists will be submitted to a certification subgroup setup by Working Group B. The subgroup, made up of expert listeners, will critically monitor the audio segments for approval. The objective of this process is to identify at least eight test segments that are suitable for system evaluation. Of these at least two segments will be selected that are considered critical for each proponent system. Finally, at least three segments will be selected for transmission impairments testing.

For the second part of the test K-2, the eight or more quality audio test segments selected in K-1 will be transmitted through each DAR system without impairments. Digital audio recordings will be made of each segment as transmitted through each proponent system and the tapes sent to the CRC for expert assessment. The method used for assessment is in compliance with the procedure recommended by the CCIR for testing low bit-rate audio coding systems with small impairments as described in [1]. The facilities at the CRC will be used for both the quality test K and impairment test B assessments. The quality and impairment test procedures were submitted to the EIA-DAR Working Group B on July 23rd, 1993 by the CRC [2].

IBOC ->HOST ANALOG TEST L and HOST ANALOG->IBOC TEST M

The IBOC to analog will be conducted for both the FM and AM based systems. The test will compare the performance of a reference analog transmitter with the performance of the IBOC analog channel. A precision FM demodulator, one monophonic receiver, five FM stereo receivers, and two receivers using subcarrier groups A and B will be used for these FM tests. Two monophonic and two stereo AM receivers will be used for the AM tests.

CONCLUSIONS

After 18 months of deliberation and preparation, the laboratory testing of multiple types of digital radio systems has begun in the United States. Field testing should start later this year. The technical report on the laboratory tests should be ready for distribution to the parent committees before the end of the year. The field test report should soon follow. It is hoped that information gained from these tests will help the digital audio radio committees, participating industries, and government make a technically informed decision in the standardization process.

REFERENCES

[1] CCIR Draft New Recommendation, *Subjective Assessment of Audio with Small Impairments Including Multichannel Sound Systems*, Task Group 10/3, Geneva, Switzerland, 1 November 1993.

[2] Thibault L. and Grusec T., *EIA-DAR Listening Tests - Quality and Impairment Test Procedures*, Submitted to the EIA-DAR Working Group B by the CRC on July 23, 1993. Updated version December 1993.

APPENDIX A

The Laboratory RF Transmission Tests REV #9
November 29, 1993

A. Calibration: Daily, Weekly, and Monthly

B. Signal Failure Characterization
1. Noise
2. Co-Channel
3. Multipath and Noise

C. DAR Performance with Impairment

D. DAR -> DAR with no other Impairments:
Co-Channel, First, and Second Adjacent

E. Test D with Multipath

F. DAR -> Analog no other Impairment:
Co-Channel, First, and Second Adjacent

G. Test F with Multipath on FM

H. Analog -> DAR no other Impairment:
Co-Channel, First, and Second Adjacent

I. Test H with Multipath

J. Reacquisition (Hysteresis)

K. Transmission Quality
1. Test Materials Selection
2. Transmission Quality

L. IBOC -> Host Analog

M. Host Analog -> IBOC

N. Multiple Spurious
1. DAR + FM -> FM